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Airborne Measurement of the Space/Time Properties of Waves in the Coastal Zone

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LONG-TERM GOAL

Our long-term goal in this project is to utilize a newly-developed airborne microwave technique to monitor the propagation of waves from the deep ocean into the coastal zone.

SCIENTIFIC OBJECTIVES

Our scientific objectives are to investigate the generation of forced waves produced by quadratic nonlinearities, the refraction of swell in shallow water, the possibility of determining bottom topography from refraction, and the effects of bottom topography and composition on the reflection and attenuation of swell propagating shoreward.

APPROACH

Our approach is to fly a coherent real aperture radar (CORAR) on a NOAA Twin Otter aircraft in order to make images in a sidelooking mode of the waves propagating toward shore and to measure their directional spectra and the accompanying wind speed utilizing a simultaneous rotating mode. By obtaining wave spectra from both the imaging and rotating modes, we will obtain the dispersion behavior of any spectral peaks and thus determine the order of the interaction that produced them. We will also attempt to extract currents from CORAR's rotating mode and compare them with currents simultaneously measured by a shore-based CODAR. We will fly along with two NOAA radiometers that will measure air/water temperature as well as wind speed and direction. Finally, we will fly in formation with a NOAA LongEZ airplane which will measure atmospheric turbulence and directional wave spectra at low altitude. We will compare our measurements with theirs.

WORK COMPLETED

Since this project was funded in March 1997, work has focussed on modifying the existing hardware and software to allow CORAR to operate at the speeds of the Twin Otter and to operate in both the rotating and imaging modes simultaneously. We are also modifying the software to allow quasi-real time processing of the data collected.

All of the necessary hardware has now been ordered using funding under a DURIP grant and most of it in presently in hand. The single piece of equipment that is not now on hand at APL/UW is the HH polarized, rotating antenna, and it is expected soon. We have purchased two new ADSP boards to use

with the two modes of CORAR; both have now been delivered and tested. We have purchased two new, dual-processor Pentium computers that will be utilized for the simultaneous data collection and processing. The antenna mount for the rotating antennas has been constructed and is in final testing.

During the past year, we have developed a digital technique for removing Doppler shifts caused by the plane's motion. This technique is much easier to implement than our previous scheme based on stepping the local oscillator. We will use the digital technique during our initial flights of the system.

Major software modifications have now been completed and bench tested. Soon we will connect radar and computer to test in a field situation; this will be the final test before mounting the entire system in an airplane. We have decided to use Windows NT as an operating system and have reprogrammed the display to accommodate this choice. The two new ADSP boards are very different from those previously used and allow much faster operation. Our decision to attempt to do quasi-real time data analysis is presently being implemented on the dual processors. We will collect the data using a C++ program and will analyze the data shortly after it has been collected using Matlab programs that have been developed during analysis of our previous airship data.

RESULTS

We are in the process of analyzing two sets of data from previous operations of CORAR on an airship. In both of these data sets, images of surface waves were obtained with CORAR's antenna pointing alternately into and perpendicular to the wind. The images were obtained in both cases immediately after CORAR had been operated in its rotating mode. Utilizing the output from these two modes has clearly shown that surface waves are present which do not conform to the first-order dispersion relationship. In one set of data, it appears that these waves do satisfy the second-order relationship. In the other set of data, however, this assessment is more problematic and is still under analysis.

The first flights of the modified CORAR system are planned for February of 1999 in a pilot experiment also involving the buoys being developed by the University of Miami. The main experiment of the Shoaling Wave Project will occur in November of 1999.

IMPACT/APPLICATION

This project will shed new light on the interactions that occur when long ocean waves propagate onto continental shelves. In addition to this scientifically-interesting impact, the results will also allow an assessment of the feasibility of determining ocean conditions near denied coastlines by means of coherent radars mounted on remotely piloted vehicles.

TRANSITIONS

CORAR has not yet been transitioned.

RELATED PROJECTS

This work is a direct outgrowth of research funded under the core program of the Space and Remote Sensing Program.